

# Urban Sprawl Pattern and Its Implications for Urban Management (Case Study: Zaria Urban Area, Nigeria)

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**ABSTRACT:** Urban sprawl, or the unplanned and uncontrolled spreading out of built-up areas in Zaria urban area causes problems of congestion, poor urban basic infrastructure delivery and poor urban planning. This paper analyzed the pattern and implications of urban sprawl using GIS and Remote sensing as an improved approach to analyze and explain sprawling beyond the traditional spatial or cartographic mapping and monitoring method which lacks the effectiveness to analyze and explain the details of spatio-temporal dimensions of urban sprawl. Map overlay analysis was used to calculate the rate and magnitude of the growth pattern for the four epochs of 1976, 1990, 2000 and 2014 if it could be regarded as sprawl. Results revealed that ribbon and leap-frog pattern of sprawl had fully developed North-South at approximately 25km stretch (Kano-Kaduna road) and 16km East-West on the regional arterial roads (Sokoto road and Jos road). Findings also revealed that the sprawl patterns were as a result of rapid urban population growth, increase demand for land, poor urban planning and social segregation with their respective implications. The causes of having such widespread urban sprawl needs to be studied in order to control the City's growth.

**Keywords:** *Sprawl, Leap-frog, Spatio-temporal, Implications and urban planning.*

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## INTRODUCTION

Planning is a decision making method that aims at achieving a desired goal with a given resource and time frame. Urban planning should be viewed in this context particularly with the objectives of addressing the prevailing socio-economical and physical problems of the given town (Haimanot, 2009).

The accurate definition of urban sprawl may be debated but a general consensus is that urban sprawl is most simply defined as the spreading out of a city and its suburbs over more and more rural land at the periphery, driven by multitude of processes and leading to inefficient resource utilization (Bullard, 2000). Urban sprawl has become a negative term without any serious examination of its qualities or benefits and without any critical analysis of its troubled alternative urban congestion while the formation of the world's cities has always been determined by the means of transport available (Abimbola, 2008).

Due to rapid population growth and urbanization, there has been

a rapid rate of sprawl in urban areas globally. As the population increases to accommodate this growth, the resultant effect is sprawl mostly at the fringes or highways. This phenomenon has led to the loss of agricultural land, open spaces and ecologically sensitive habitat. Other negative impacts of urban sprawl are; increase in automobile transportation, congestion, economic segregation and air and water pollution among others (John, 2006).

Urban sprawl is not entirely a bad phenomenon. Some positive impacts of urban sprawl are; increased satisfaction of housing preference and generation of an increased number of suburban local governments which are likely to have lower crime rate and better schools (John, 2006). Urban sprawl is formed as a result of the development pattern which brings about implications on the city and its management causing excessive land consumption due to undervaluation of open space, congestion due to increased commuting and socio-economic segregation due to exclusionary housing market.

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Sprawl development is now perceived as contributing to fiscal costs for providing infrastructures and public health problems (Carruthers & Ulfarsson, 2002).

In a developing country such as Nigeria, development in urban areas and miscellaneous land use types are isolated in the fringe areas followed by gradual filling of intervening spaces with similar uses, this is mainly due to rapid growth in population size which is usually uncontrolled. Urban Sprawl is a growing concern of citizens, environmental organizations and governments.

Zaria urban area has been experiencing sprawl over the years due to its increase in population which had led to rapid expansion that had left profound changes on the landscape in terms of land use and land cover. Zaria urban area is a host to several government educational institutions which attracts rapid influx of migrants from all over the country in search of food, shelter, better education and job opportunities.

Urban sprawl in Zaria urban area is characterized by physical and socio-economic problems such as traffic congestion, loss of open spaces, segregation, very poor infrastructure, and lack of basic facilities in the sprawled areas, loss of vegetation land and increased air pollution and water pollutant runoff into natural waterways. This paper reports on a study of the pattern and implications of urban sprawl as it applies to Zaria Urban Area in Kaduna State, Nigeria.

### **Concept of Urban Sprawl**

Urban planning evolved throughout the twentieth century, leading to a great variety of urban forms which often had little regard for their impact upon the environment. In both developed and developing societies, this disregard is most evident in the rise of urban sprawl as the primary form of urban development, one which has come under increased criticism in recent years because of its negative environmental, social and economic effects (Newman & Kenworthy, 1999; Hillman, 1996; de Roo & Miller, 2000; Jensen, 1996; Breheny, 1992; Elkin et al., 1991, Cited in Duany et al., 2000).

Definitions of sprawl according to density attributes of a settlement system: these definitions consider low density forms of settlement, decreasing density and functional decomposition of cities as sprawl. Representatives of these definitions are for example Glaeser & Kahn, 2003, Fulton et al., 2001. Cited in Siedentrop (2005).

Definitions of sprawl characterized by structure and form attributes of a settlement system. Sprawl is understood as an urban form building process that transforms a former monocentric compact structure into a discontinuous, polycentric and dispersed settlement structure (Galster et al. 2001, Torrens, & Alberti 2000. Cited in Siedentrop (2005).

Microsoft Encarta (2005), gives the definition of urban sprawl as the outward spread of built-up areas caused by their expansion. The expansion of the urban area is towards its country-side that surrounds it. The urban sprawl is believed to be one of the by-products of urbanization. Cities are generally regarded all over the world as providing the engines of economic development both for the cities themselves and their surrounding rural

hinterland.

Galster 2001 understands sprawl as a condition of land use and states that general approaches to sprawl can be by aesthetics, efficiency, equity, and environmental aspects.

Defining sprawl as the cause of an unwanted (negative) externality: definitions reach from judgments on the appearance of sprawl to alleged causal links between sprawl and its effects on land use patterns in the form of environmental, social and economic costs. These definitions are treating more the consequences than the attributes of sprawl (Downs, 1999).

Urban sprawl may be defined as the scattering of new development on isolated tracts, separated from other areas by vacant land (Lata et al. 2001). It has also been described as leapfrog development. Jothimani, 1977; Torrens & Albert, 2000 cited in Duany et al., (2000).

European Environmental Agency, 2006 defines sprawl as the physical pattern of low-density expansion of urban areas, under market conditions, mainly into the surrounding agricultural areas. According to the same source, this results in a patchy, scattered, strung out, discontinuous and leapfrogged landscape.

### **Characteristics of Urban Sprawl**

There are many characteristics that can be associated with the term urban sprawl although there remains debate in the planning literature with regards to the development of an exact definition for the term, and disagreement whether particular urban forms should be categorized as urban sprawl or not. According to Gillham (2002) there are four main characteristics of sprawl, which mirror the earlier definition given. These characteristics are leapfrog or scattered development, commercial strip development, low density, and large expanses of single-use development.

Due to uncontrolled urbanization, one major feature of Nigerian cities is urban sprawl. The urban sprawl is characterized by haphazard housing development in the urban suburbs, where majority of the structures are without planning permit in uncoordinated layouts. Often times, these structures are products of squatters that choose to settle at the suburbs as a result of their inability to afford residential accommodation in the city.

The improper coordination of the physical development promotes high level of inaccessibility within the area. Such areas lack essential social and welfare infrastructure like water, electricity, health care and educational facilities among others. The unsanitary conditions in the area pose a continuous threat to healthy living of the inhabitants and it is an area regarded as a place that is dangerously unsafe for living because of its associated social vices. Above all, urban sprawl presents a repulsive outlook of the city space that calls for re-planning. Unfortunately, there is no Nigerian city that can be exonerated from the stigmatization of urban sprawl. This has prompted Farunkanmi, 2003 Cited in Julius, (2009), to draw the attention of town planners to the implications of sprawling city that if the governing authorities fail to inject the essential infrastructural facilities, such neglect would pose serious and dangerous implications for human health, progress and development. From

the discussion so far, urban sprawl poses a lot of challenges to town planners, city managers, governments and stakeholders.

## MATERIALS AND METHODS

Firstly, remotely sensed satellite images of varied resolutions was obtained from GLCF (Global land Cover facility) and United State Geological Survey (USGS), which covers the study area and its environs for four epochs. The four images used for the study are the Landsat Multispectral Scanner (MSS) of 1976 with 80 meters resolution, Landsat thematic mapper TM 1990 with 30 meters resolution, Landsat ETM+ image of 2000 with 30 meters resolution and Landsat (Combine) Operational Land Imager & Thematic Infrared Sensor (OLI & TIRS) of 2014 with 30 meters resolution. These four imageries of varied intervals were preprocessed using Edras Imagine for image correction and enhancement of poor quality images and enhancement of low resolution images, after this, the images were layer stacked (band composite) for easy classification.

Secondly, processing of the corrected and already enhanced satellite imageries was established using ArcGIS 10.1 by applying true colours and false colours to the already layer stacked imageries for easy classification of the imageries. The study area was then clipped/carved out from the whole scene (path 189 row 52) of each imagery which developed land cover classes using Maximum Likelihood Classification. Each class was calculated at the end of the classification process to determine the total size of each land cover in hectares for subsequent analysis.

Thirdly, the result of the different land covers from each epoch was applied in GIS using Overlay analysis Module in which compared the land cover statistics that detected the percentage change, trend and rate of the study area between 1976 and 2014. The result of the above analysis determined the pattern of urban

sprawl in the study area.

## RESULTS AND DISCUSSIONS

### Sprawling in Zaria Urban Area

Zaria Urban area is located between latitude  $10^{\circ}57'36''N$  and  $11^{\circ}15'32''N$  and  $7^{\circ}39'00''E$  and  $7^{\circ}53'02''E$ . It is made up of it Sabon Gari and Zaria local government areas (Oladimeji, 2012). The population of Zaria is approximately 975,153 (projections from 2006 national census).

Zaria Urban Area is bounded by Kudan to the North, Igabi to the South, Soba to the East and Giwa to the West. Zaria is about 26 km from Kudan, 50 km from Igabi, 40 km from Soba and 29 km from Giwa.

It is defined by a 15Km radius from the PZ post office and is well connected by roads and railways with other regions of the country. Distances from Kaduna, Kano, Jos and Sokoto are approximately; 75Km, 176Km, 387Km and 404km respectively. Zaria is the second principal town in Kaduna state and home to the Ahmadu Bello University, and a host to several other federal government institutions. In figure 1 Locational Map of the study area was shown.

After classifying the Landsat images for the four epochs (1976, 1990, 2000 and 2014) of Zaria urban area to establish the different forms of development which determines the sprawl pattern of the study area in 2014, the classified imageries formed the basis for the analysis of sprawl pattern to be carried out in this study area. Each map of a study year is made up of four different classes of land cover, which are classified into built-up, vegetation/green area, bare land surface and water body which have resulted in a simplified representation of the study area. (Fig 2-5) In table 1 Proportion of Built-up change from 1976-2014 was shown.

After carefully understanding the urban structure and character of Zaria urban area by examining the pattern of its component

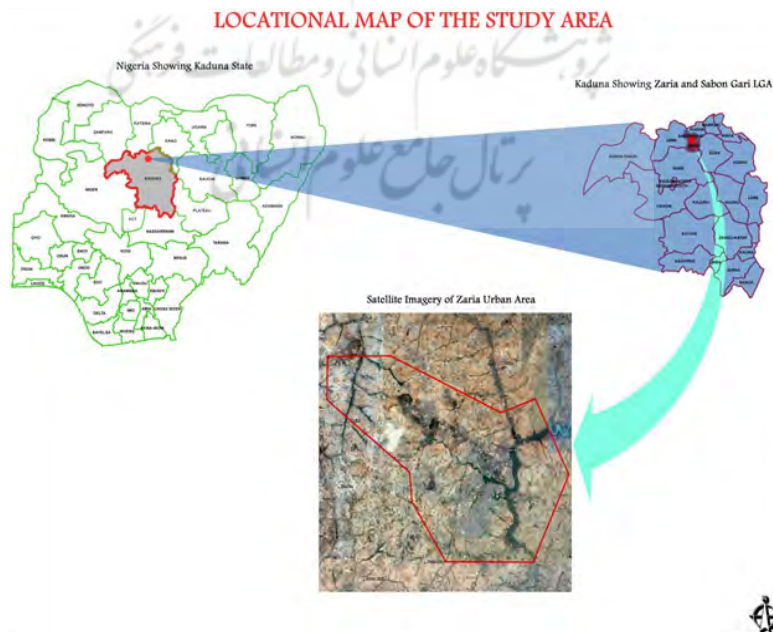


Fig. 1: Locational Map of the study area

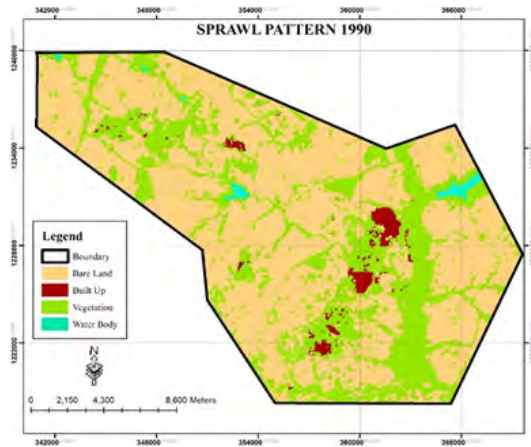


Fig. 2: Zaria Urban form 1976

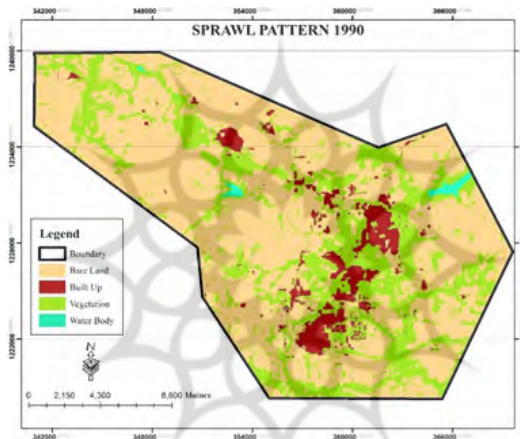


Fig. 3: Zaria Urban form 1990

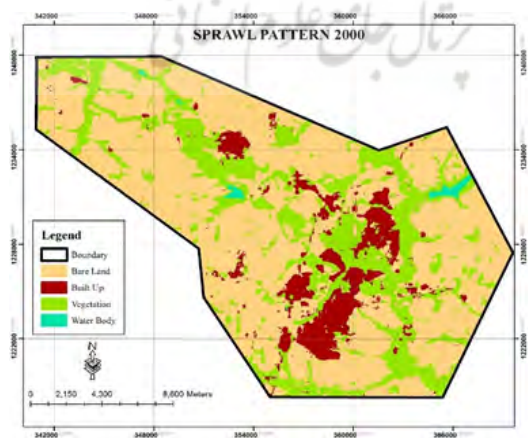


Fig. 4: Zaria Urban form 2000

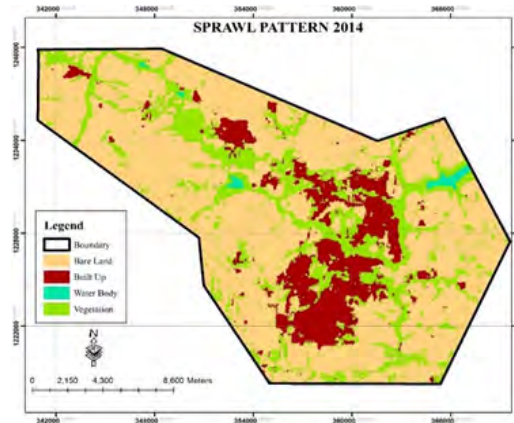


Fig. 5: Zaria Sprawl Pattern 2014

Table 1: Proportion of Built-up change from 1976-2014

Year	Area (ha)	Area (%)
1976	1203.99ha	3.3%
1990	3811.52ha	10.5%
2000	4765.75ha	13.1%
2014	5986.34ha	16.5%
TOTAL	15767.6ha	43.4%

parts and the process of its development, this evolves the analysis of its spatial structure/form at different epochs as well as patterns of movement of the built-up fabric. The calculation of the proportion of sprawl pattern for the epochs from 1976 -2014 was performed using vector overlay and statistical analysis techniques. In order to have a clear understanding and a brilliant visualization of the overlay analysis, the four epochs were used and the analysis was done for the built-up fabric.

It can be seen in figure 5 that ribbon pattern of development and leap-frog pattern of sprawl had fully developed North-South with the urban area spanning approximately 25 km on the North-South axis along Kano - Kaduna road, to the South-West along Gwargwaje - Kufena (Birnin Gwari road), to the North-West along Sabon gari – Samaru (Sokoto road) and Jos regional arterial road as compared to the 16 km on the East-West axis. (Fig 6)

This form suggests a continuous dispersal of development but at the same time infilling of the spaces between the scattered patches of development especially along the roads linking them. (table 2 -4)

#### Urban Management Implications of Sprawl

Consequences of sprawl may have both positive and negative implications; however, negative implications are generally

more highlighted because this sprawl is often uncontrolled or uncoordinated and therefore the negative implications override the positive sides. Positive implications of urban sprawl include housing for the poor urbanites, opportunities for the underemployed and unemployed. The negative implications are discussed as follows:

**Impact of Poor Urban Planning and Management:** Field survey revealed that the roads reserves are converted to commercial layouts, in contrary to provision of developmental plan and layout plan. The access roads in most of the sprawl areas are not up to standard as observation has shown that the sizes of access roads in some traditional wards are even more standard and larger than that of some new expansions/ layouts within the study area.

From the field survey, it shows that layouts/communities that are unapproved by Government expanded more than twice the number of the approved layouts under approved and gazette development plans. This threatens danger for current land administration and management. If land is to play its role as a veritable asset and commercial commodity that can be used as security and collateral for loans and mortgages, then its management and administration must inspire the requisite confidence.

Urban Growth Rate Implication for Zaria Urban Area:

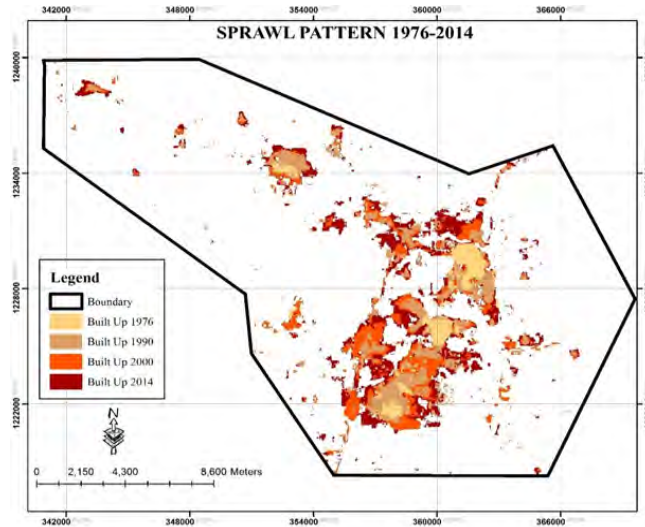


Fig. 6: Pattern of sprawl between 1976-2014

Table 2: Trend analysis for rapid urban population between 1976-2014 (Source: Field Survey, 2016)

Interval	Population Increase	Built-up increase (%)	Remarks
1976-1990	176,000-500,424	3.3%- 10.5%	The growth of Zaria urban area increased from 176,000 persons to a projected population of 500,424 persons within this period, which is attributed to the history of Zaria with small agricultural activities and with the increase activities within the main tertiary institution in samara and few others. E.g Polytechnic, Industries around Chikaji.
1990-2000	500,424-650,582	10.5%-13.1%	At this period, population kept increasing at a low rate as a result of activities within other institutions such as F.C.E Zaria, Military deport etc.
2000-2014	650,582-984,218	13.1%-16.5%	Significant increase was recorded at this stage from 650,582 persons to 984,218 persons as projected is also as a continuous increase in economic activities of the study area which is a pull factor.

Table 3: Trend analysis for increased demand for urban land between 1976 – 2014 (Source: Field Survey, 2016)

Interval	Built-up Increase (Ha)	Built-up increase (%)	Remarks
1976-1990	1203.99h- 3811.52h	3.3%- 10.5%	From the base year in 1976, Zaria urban area exhibited isolated or leap-frog pattern of development at the early stage of its development in which the built-up covers about 1203.99 hectares and rapidly increased to 3811.52 hectares by the year 1990.  The astronomical rise in population translated into accelerated urban expansion during this decade.
1990-2000	3811.52h-4765.75h	10.5%-13.1%	There was limited increase in urban expansion during this period because most expansion in urban land was limited to infilling of spaces within the four districts in the study area forming strip pattern developments. Some peripheral expansion however continued to occur as dispersed settlements.
2000-2014	4765.75h-5986.34h	13.1%-16.5%	Significant increase was recorded at this period which is attributed to further outwards expansion along the major roads as a result of .increased demand for land by the increased population

Table 4: Rate and Magnitude of Change (Source: Field Survey, 2016)

Interval	Built-up Increase (Ha)	Built-up increase (%)	Trend Percentage Change (Observed) (change/ Sum of change × 100)
1976-1990	2,607.53h	7.2%	54.52%
1990-2000	954.23h	2.6%	19.95%
2000-2014	1,220.59h	3.4%	25.53%
<b>TOTAL</b>	<b>4,782.35h</b>	<b>13.2%</b>	<b>100</b>

Computing the rate of urban growth for Zaria was also achieved in this paper by employing the mapping, measure area and map calculator modules in GIS to compute the area statistics of the built extent of Zaria Urban Area for the four epochs. The difference in area of the built extent between one epoch and the preceding one was computed and from the statistics, it was possible to estimate the growth rate for Zaria urban area put at a substantial 87.16h (0.87km<sup>2</sup>) annually. This excessive physical growth rate is most likely to result in further sprawling with all its associated implications as there is no reason to suggest that growth will be in any other form or pattern. Furthermore, if the current rates of population increase and physical expansion are unrelenting, Zaria Urban Area is likely to double its size in spatial extent in the next 80 years.

**Inflated Infrastructure and Service Delivery Costs:** Residents of the sprawled areas are faced by an enormously costly delivery of urban infrastructure and services. 95% of the sprawled areas are experiencing increase in demand for public infrastructure and services such as schools, pipe borne water, electricity, transformers, fire-service stations, police stations, hospitals, roads, drainages and refuse collection points and dumps as well as the maintenance and improvement. These expansions require more infrastructures, since it takes more roads, pipes, cables and wires to service these areas compared to more compact developments with the same number of households. As long as developers are responsible for the full costs of neighbourhood infrastructure and pass such costs on to land buyers and other end-users of land, lower-density development patterns will meet the test of economic efficiency (at least with respect to infrastructure costs). It may be mentioned that from the standpoint of community-level infrastructure, costs do not vary so much with residential density but with the degree of clustering and/or proximity to existing development.

**Environmental Implication:** The field survey reveals that, residential areas at Sabon-Gari, Zaria-wall, Tudun-Wada, Kwangila and Samaru axis encroached the water logs, while the constructed central drainage channel is not draining the water, the water logs blocked of road side drainage channels which is vulnerable to flooding. The attitude of residence of disposing refuse in the drainage channels and water logs in the sprawled areas apart from polluting the water, breeding mosquitoes, also created a serious unpleasant odour, capable of

affecting the health of inhabitants.

A study by Abaje et al., 2012, estimated that because of the increase in impervious cover in an area with flood plains, a flood event that should be expected once in 100 years could occur once every 5 years when the impervious cover reaches 25%, and could become an annual event when impervious cover reaches 65%, as such Zaria urban area has experienced increase in built-up cover from 3.3% to 16.5% from 1976 to 2014, which if continue into the future without any proper measure taken may make the study area more vulnerable to flood events.

**Socio-economic Implications:** A critical visual interpretation of the land cover change maps reveals that the built-up were surrounded by agricultural land (basically vegetation and bare land cover), this implies that as built-up increases, vegetation and bare land decreases i.e. the change in built-up encroached on valuable agricultural land, as such the socioeconomic effect of land cover change in study area can be seen as follows;

- It poses a serious threat to agriculture
- The issue of food security
- Significant loss in the economy of food and income base for a reasonable amount of the population in the area under study.

## CONCLUSION

Urban sprawl has increasingly become a major issue in the global trend towards urbanization. Faced not only by developed countries but also by developing countries, and by large urban centers and medium and small cities alike, urban sprawl raises social and environmental concerns at the same time that shows a multiplicity of divergent trajectories that somehow defy the dominance of homogeneous characteristics around the world. This paper examined the sprawl pattern of Zaria Urban Area using GIS and remote sensing as well as drawing implications of it and proffered solutions in controlling it.

According to the findings of this paper, uncontrolled urban sprawl in Zaria has caused many changes in the land use along the major roads at the peripheral areas. The causes of having such widespread urban sprawl should be studied in order to develop strategies for controlling the city's growth. Some of the strategies and policies that can be used for controlling the urban sprawl are: creating a regional balance to reduce migration from rural areas to urban areas or the renewal and

improvement of the central-historical fabric of Zaria urban area. This would cause the continuous settlement of population in these areas for living and would prevent migration from center to the suburbs. Also, the policy of infilling development can be used to provide for the future growth of the population, and for implementing strategies addressed to manage the construction in the undeveloped areas.

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